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TELEPHONE TRAFFIC - DIAL EQUIPMENT FOR TOLL CENTERS

CONTENTS

1. GENERAL

1.1 This section is intended to provide REA borrowers, consulting engineers, contractors, and other interested parties with technical information for use in the design and construction of REA borrower's telephone systems. It describes in particular the equipment arrangements and methods for determining the number of switches and trunks required for handling incoming toll traffic at a toll center on a dial basis.

1.2 The term "toll center" as used in this section is an office where operators record and complete toll calls to all points in the country and where facilities are provided for completing incoming toll calls including arrangements for operator assistance where required on incoming calls. These facilities consist of manual switchboard positions in all cases and toll dialing equipment where incoming toll calls are completed by dialing. Most toll centers handle the toll traffic for a number of nearby communities, called tributaries, as well as the toll calls originating and terminating in the toll center community itself.

1.3 Incoming toll calls at a toll center may be for local numbers in the toll center itself, for local numbers at any tributary, for operators, or for testing facilities at the toll center. The toll dial equipment must be designed to handle incoming calls to each of these.

1.4 Calls for operators include connections to "Information" where the telephone number of the called party is not known, reports of "Ready-to-talk" on person-to-person calls that were delayed and on which word was left to call back and requests for assistance from an inward operator when difficulty is encountered in reaching a particular telephone. Calls for testing facilities also are completed in response to dial pulses to facilitate testing intertoll trunks without the assistance of a maintenance man at the toll center.

1.5 The toll dial equipment is required to receive the office codes for the local offices at the toll center and for the tributaries it serves and to complete calls to these local offices in accordance with the dial pulses received. Calls to operators and to test facilities are completed on receipt of standardized 3-digit codes.

1.6 In this section it is assumed that the reader is familiar with other material that has been issued on dial equipment, on manual toll boards and on toll operation. This includes the following sections of the REA-TE & CM and REA Forms 542a, b and c covering manual toll boards:

Section 156, Nationwide Toll Dialing
Section 157, Customer Toll Dialing Within Limited Networks
Section 208, Numbering Plans
Section 325, Application Guide for the Preparation of Dial Central Office Equipment Requirements
Section 501, Telephone Traffic - Qualitative Discussion
Section 510, Telephone Traffic - Dial Central Office Equipment

2. OPERATOR AND PLANT TEST CODES

2.1 Standard codes have been established for reaching operators and for plant testing purposes, some of which are needed at all toll centers while others are provided only where locally required. Following are the operator codes and their purpose.

2.11 Inward - 121. Used by operators in distant cities when assistance is required such as verifying a continued line busy or trunk overflow condition. During transition period to Nationwide Dialing some calls may have to be referred to an Inward operator because the calling operator is unable to dial into the end office. Trunks terminate on manual toll board. Required at every toll center.

2.12 Information - 131. Used by operators in distant cities to obtain telephone numbers at the toll center and at its dial tributaries. Trunks terminate on Information desk where provided, otherwise on manual toll board. Required at all toll centers.

2.13 Route - 141. Used by operators at decentralized outward switchboards to obtain route or rate information from a route and rate desk. Generally applicable only in larger metropolitan centers.

2.14 Toll Station - 181. Used by operators in distant cities to reach a special position on the manual toll switchboard where connections are made to toll stations. Required only where there are toll stations.

2.15 Universal TX - 1150. Used by operators in distant cities when connection is required with an outward operator such as on collect calls to coin station and "Ready-to-talk" reports on delayed person-to-person calls on which word has been left to call back but the party does not know the operator number. In the smaller toll centers where only one delayed call (TX) position is needed it is customary to use "50" as the operator number on all delayed calls. Trunks terminate on manual toll board. Required at every toll center.

2.16 Delayed Call (TX) - 11XX or 11XXX. (X refers to any numeral between 0 and 9). Used in larger offices where delayed calls are assigned to two or more TX groups.

2.2 Plant Test Codes - 100, 101, 102, 103 and 104. Used for testing intertoll trunks. Provided only when locally required.

2.3 The toll centers in REA borrower's systems generally are small with no specialized inward and outward positions. Under these circumstances the codes 121 and 1150 may be tied together and only one trunk group provided to the manual toll board. This reduces the number of trunks required.

3. ARRANGEMENT OF EQUIPMENT

3.1 Figure 1, illustrates a
center with three outlet
Three of the tributaries
The illustration shows
of each office in the G

3.2 With the offices and tr
center A is required to
local numbers at A and
"564" connection must b
tributary F and a two-s
if it is ringdown, or a
battery.

3.3 Figure 2, illustrates a switching schematic that will meet the requirements for Toll Center A in Figure 1. Step-by-step equipment is assumed for simplicity but the same plan is applicable to any direct-control type system. A common-control installation seems unlikely for REA borrower's toll switching systems and if considered, will require special study.

3.4 In this illustration it is assumed that the toll dial equipment at the toll center is required to complete connections to operators and to the test facilities only in response to codes 121, 131, 1150, 101, 102, 103, 104 and 100.

3.5 Intertoll first selectors and auxiliary first selectors usually are equipped for digit absorption and others may be so arranged where desirable. Where working levels on intertoll first selectors are reached after dialing an unlocking digit, it is desirable to return a busy signal if an unlocking digit is not dialed first. This will prevent the completion of some wrong-number calls.

3.6 Figure 2, shows a trunk group from level 3 of the intertoll first selectors to the local office in the toll center. These terminate on incoming toll selectors which are considered part of the local office. A similar group from the toll board to the local office is provided for the completion of calls from the tributaries to the toll center, for handling delayed calls and for completing some incoming calls received over 121 trunks. These are called "Toll Switching Trunks."

3.7 The arrangement illustrated in Figure 2 provides a high degree of flexibility in making use of the office codes assigned and it leaves room for adding a number of new tributaries with no change in the switching plan. Other plans, requiring fewer selectors, but with less flexibility and less capacity for growth are described in Paragraph 4.4.

SWITCHING LEVEL ASSIGNMENTS

codes for the toll center and for the tributaries
he Bell Associated Company serving the area.
pattern is followed of using the same
r several tributaries but different letters
itself. This facilitates extended area
trunks are provided and usually is well
nking. However, the codes assigned can not
individual toll center and one or two
more economical switching system as described

4.2 Since the number of intertoll first selectors is fixed by the number of trunks the first objective is to handle as much traffic as possible directly on these first selectors in order to reduce the number of intertoll second selectors required. The toll center itself usually has more toll traffic than any of its tributaries and where this is the case, it is desirable to serve the local office directly on the first selector. This has been done in the example illustrated by Figure 2 by assigning the toll center and two tributaries to levels 2, 3 and 4 of the intertoll first selector and the two remaining tributaries to levels 3 and 4 of the intertoll second selectors. This plan leaves a number of levels available for additional tributaries and does not require digit absorption on the incoming toll selectors at any of the local offices.

4.3 In the event that there is more traffic to tributaries E and F than to toll center A and tributaries G and H, it would be more economical to reverse the assignments to first and second selectors as illustrated in Schematic A of Figure 3. This can be done with no code change.

4.4 Schematics B, C and D on Figures 3 and 4 illustrate what can be done by one or two code changes. Schematic B, Figure 3 shows how all offices can be reached directly from the first selector by obtaining two code changes, thereby eliminating the intertoll second selectors. Schematic C, Figure 4 shows how one code change permits combining the intertoll second and auxiliary first selectors with a resulting gain in efficiency. Schematic D, Figure 4 also eliminates the intertoll second selectors with a different code change but with the penalty that digit absorbing selectors must be installed at tributary E initially and at F when it is converted to dial. All of these arrangements, of course, limit the capacity of the switching system in the number of tributaries that can be served, and are dependent on obtaining suitable code assignments.

4.5 For very small toll centers with few tributaries it may be feasible to assign local number groups at the toll center directly to levels of the intertoll first selectors. This would avoid installing a separate group of incoming toll selectors in the local office. Some gain in efficiency may also be obtainable by assigning local number groups to available levels of the auxiliary first selectors. Such arrangements, of course, depend on obtaining acceptable office codes and suitable number series for local numbers.

4.6 The above examples illustrate the wide variety of switching arrangements available in dial toll centers. The economies obtainable by making the best possible use of the assigned codes or by obtaining a few code changes warrant a careful study of the switching plan for every toll center before reaching a final decision on the plan to be followed.

4.7 Manual tributary offices are treated in the same manner as dial tributaries as far as level assignments are concerned.

4.8 Greater flexibility in the assignment of codes to selector levels and greater capacity for tributaries may be obtained by using a third rank of selectors but this should rarely be necessary in REA borrower's systems.

4.9 The arrangement of auxiliary selectors to reach operators and plant test facilities illustrated in Figure 2, should be applicable in most toll centers in REA borrower's systems. In the larger offices where two or more groups of delayed operators are required, TX numbers may be assigned to levels 6, 7 and 1, and on three additional levels where codes 141, 181 and 191 are not required. In a small office, such as the one illustrated, trunks to operators can be reached without use of the last digit. With this arrangement the trunk lamp normally lights when an idle trunk is selected and if an operator asnwers before the last digit is received a "stop-dial" dignal is returned which may prevent the completion of the connection. Where the type of equipment is such that this condition can be avoided at negligible cost, it should be so arranged, otherwise, no special provision need be made for this contingency.

5. ENGINEERING BASIS FOR SELECTORS AND TRUNKS

5.1 The toll dial facilities at a toll center represent a very small part of the total plant used on an incoming toll call, especially where the call originates in a distant city and is routed through several switching centers. Therefore, it is suggested that all dial switches and operator trunks involved in the completion of incoming toll calls at the toll center be engineered on a basis that will result in about one delay in a hundred calls. (Table P = .01, REA-TE & CM-510). This is for the average busy hour in the busy season.

5.2 The estimated volume of traffic incoming to a toll center from intertoll trunks can be obtained from the connecting company responsible for providing the trunks, (generally one of the Bell Associated Companies). If no breakdown is available between incoming and outgoing traffic, it may be assumed that 55% of the total is incoming for the purpose of engineering the toll dial equipment in order to make some allowance for deviation from the usual 50-50 division. This volume usually is expressed in "Busy Hour Minutes" which can be converted to Unit Calls by multiplying by .6. (Unit Calls = 60X Minutes ÷ 100).

5.3 The incoming traffic from intertoll trunks is received on intertoll first selectors and then divides between the toll center and the various tributaries in accordance with the level assignments described in Paragraph 4 and illustrated in Figure 2. On initial

installations of toll dialing selectors in REA borrower's systems, especially where new tributaries and new trunking arrangements are to be set up, little or no information may be available on how the incoming traffic will divide. It is suggested, therefore, that the incoming unit calls be prorated between the toll center and the tributaries in the same proportion as the estimated total originating messages at the toll center and at the tributaries. These originating message figures are estimated in any case in the preparation of the Area Coverage Design (ACD). This procedure is illustrated in the example shown under Paragraph 6.

5.4 When additions are needed in the toll dial equipment, usage data on all second and auxiliary selectors and operator trunks should be obtained by switch counts or usage meters. These data can be projected to future periods and switch quantities determined on a sound basis of past performance.

5.5 The required number of auxiliary selectors is based on the percentage of incoming traffic that is routed to operators. Under current operating practices this percentage figure should be fairly uniform as between toll centers and reasonably stable even during periods of some overload or circuit congestion. For engineering purposes it may be assumed that 15 percent of the incoming unit calls will be routed to the auxiliary selectors unless there is reason to believe local conditions indicate a different figure should be used.

5.6 A minimum of two auxiliary second selectors is suggested for gaining access to the toll test circuits. This should be for toll centers up to perhaps 50 intertoll trunks gested that this requirement be discussed w company which will be making the most use o facilities.

5.7 Most toll centers in REA board positions to warra operators. Where this i codes 121 and 1150 be ti vided to the toll board. group may be estimated o on the auxiliary selecto volume of traffic for th This leaves 10 percent o minimum of two trunks is

6. CALCULATION OF SELECTORS AND

6.1 To illustrate the calcul trunks to operators and center the following exa trunking and switching a

6.2 Basic Information

Intertoll Trunks - Figure 1

Group	Number Trunks (2-Way)	Busy Hour Minutes*
A - B	15	650
A - D	5	224
A - C	3	118

Originating Toll Messages

		Per Day#	Toll Trunks
Toll Center	A -	300	-
Tributary	E -	100	4
	F -	140	6
	G -	60	2
	H -	100	4

* From company providing trunks.
\# From ACD.

6.3 The number of intertoll first selectors required is the same as the number of intertoll trunks, 15 + 5 + 3 = 23 in this example as all are two-way. If there are any one-way trunks they, of course, do not require selectors at the outgoing end.

6.4 Second and auxiliary selector requirements are developed as follows:

6.41 Busy Hour Minutes. Usage on intertoll trunk groups is converted to unit calls by multiplying by .6.

Total Busy Hour Minutes (650 + 224 + 118)	992
Incoming - Assume 55% of the total load is incoming (992 x .55)	545
Incoming Unit Calls (545 x .6)	328

This volume of incoming traffic is distributed over the various levels of the intertoll first selectors to second selectors, to auxiliary first selectors, to incoming toll selectors at A and to two tributary groups, as shown on Figure 2.

6.42 Fifteen percent of the incoming traffic is to operators and plant test circuits reached over the auxiliary first selectors.

Unit Calls on Auxiliary First Selectors 15% x 328 =	49
Auxiliary First Selectors (Table P = .01) =	6

(Refer to REA-TE & CM-510 for probability tables.)

6.43 The remaining incoming traffic is assumed to divide in proportion to the originating messages at the toll center and at the tributaries. The volume of this traffic is the total minus the 15 percent to operators and plant tests.

Unit Calls remaining (328 - 49) 279

These unit calls are divided as follows:

		Originating Messages	Percent Total	Unit Calls
Toll Center	A	300	42.8	119
Tributary	E	100	14.3	40
	F	140	20.0	56
	G	60	8.6	24
	H	100	14.3	40
	TOTAL	700	100.0	279

6.44 Incoming toll selectors at toll center A are required to handle 119 unit calls. Number required (Table P = .01) = 9.

6.45 The intertoll second selectors handle traffic as follows: (Figure 2):

	Unit Calls
Tributary F	56
E	40
TOTAL	96

Number required (Table

6.46 Two auxiliary second s
plant test codes on th
for any selector grou

6.5 Trunks to operators are deve

Unit Calls on Auxiliary Firs
Unit Calls for Inward and T
Trunks Required (P = .01)
Unit Calls for Information (
Trunks Required (P = .01)

-

6.6 It will be found helpful to prepare a complete switching schematic for all offices in the toll center area showing switch quantities and covering all selectors on which level assignments have been made such as illustrated in Figure 5.

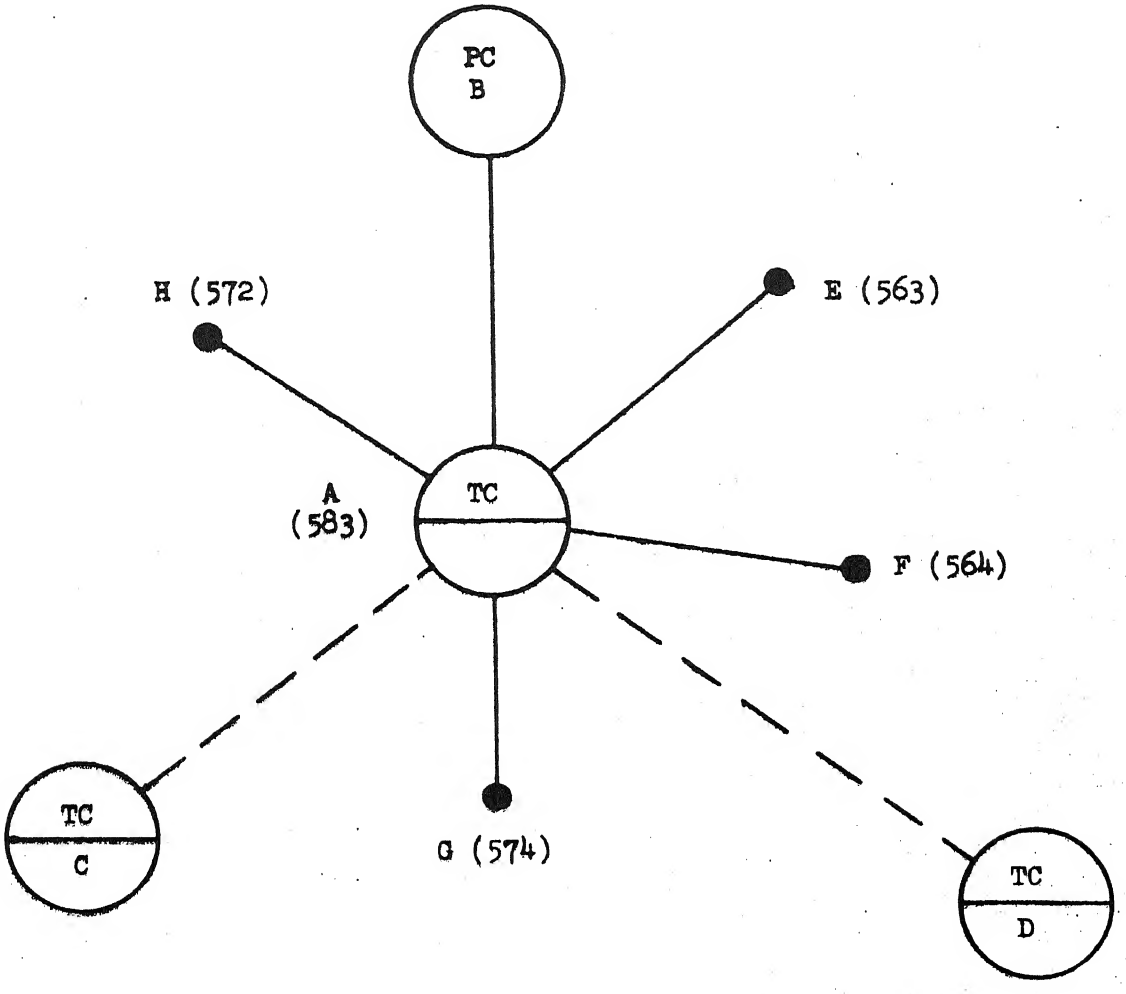
7. SUMMARY

7.1 The conversion of the local telephone system at a toll center from manual to dial operation makes it desirable to convert the terminating ringdown intertoll trunks to toll dialing wherever the distant toll center is equipped for toll dialing. This requires intertoll and auxiliary selectors, trunks to operators and usually trunks to toll test facilities. These should be adequate for handling the incoming dialed calls with a low probability of delay, such as one call in a hundred. (Table P = .01)

7.2 The intertoll selectors are arranged to complete calls to the local equipment at the toll center and to each tributary in accordance with the assigned office codes. The two letters and single numeral of the office codes generally are used up in the toll selectors leaving four numerals of the customer's number to be transmitted to the local office. Good judgment is needed in level assignments and in the use of the digit absorption feature to keep the number of second selectors at a minimum.

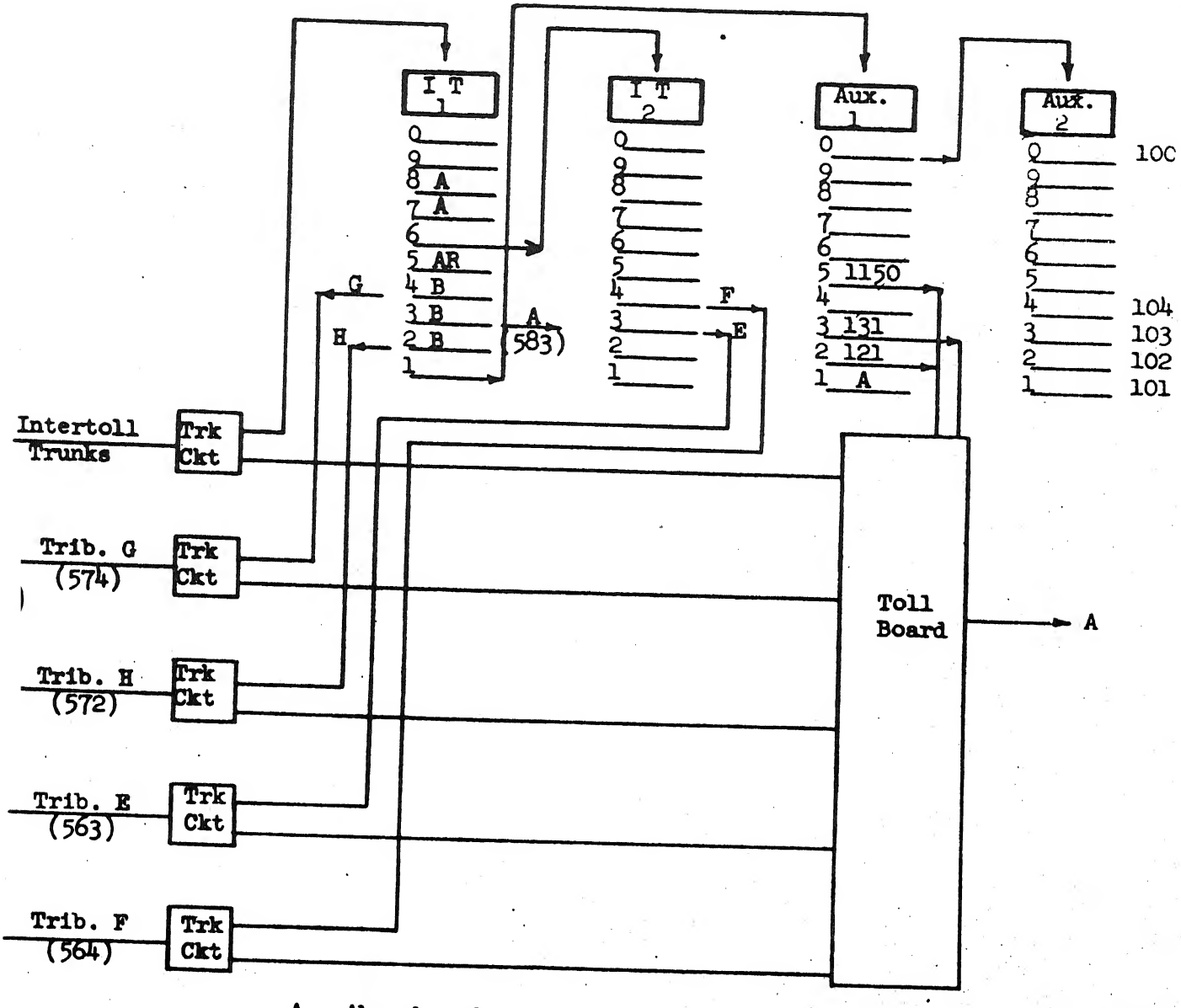
7.3 In the initial installation, the number of second and auxiliary selectors is based on the estimated volume of incoming dialed toll traffic and on a theoretical division between local offices. When additional equipment is needed, switch counts or other means should be used to determine actual usage on the facilities installed and the addition engineered on the basis of this information.

7.4 The arrangement and amount of toll dial equipment at a toll center affect primarily the outward operating at distant toll offices and the efficient use of the whole toll network. It therefore is suggested that plans for toll centers in REA
ems be reviewed with representatives of the
any serving the territory to make sure that
Nationwide Toll Dialing have been met.
n 410-1, "Scheduling Connection of New
l Network.")



B - Primary Center (PC-Class 3)
A, C, D - Toll Centers (TC-Class 4C)
E, G, H - Dial Tributaries (Class 5)
F - Manual Tributary (Class 5)
———— Final Group
— — — — High Usage Group
( ) Office Code

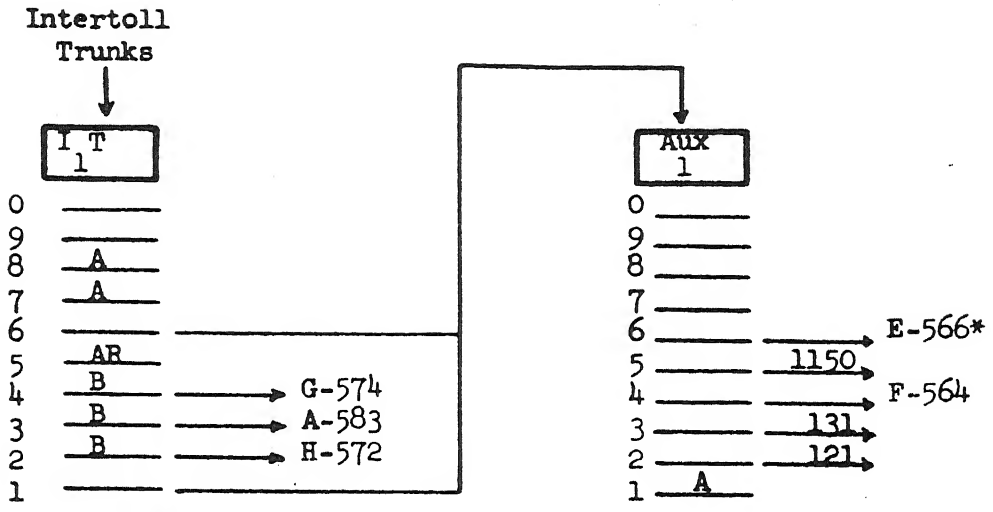
TOLL CENTER TRUNKING DIAGRAM
FIGURE 1



A - Absorb and Unlock
AR - Absorb Repeatedly
B - Block
( ) - Office Code

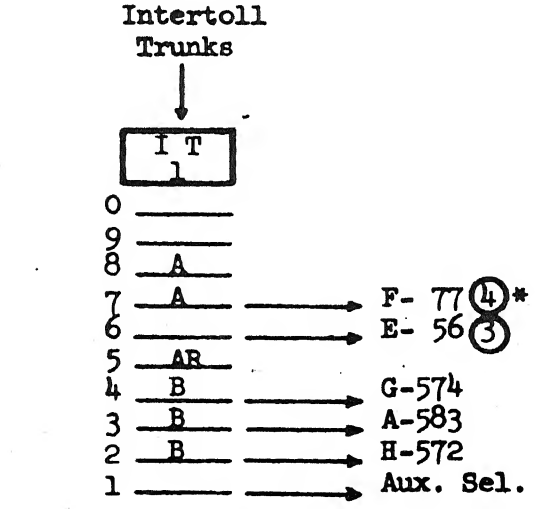
TOLL CENTER - TOLL SWITCHING SCHEMATIC

FIGURE 2



* Code Changed

SCHEMATIC C



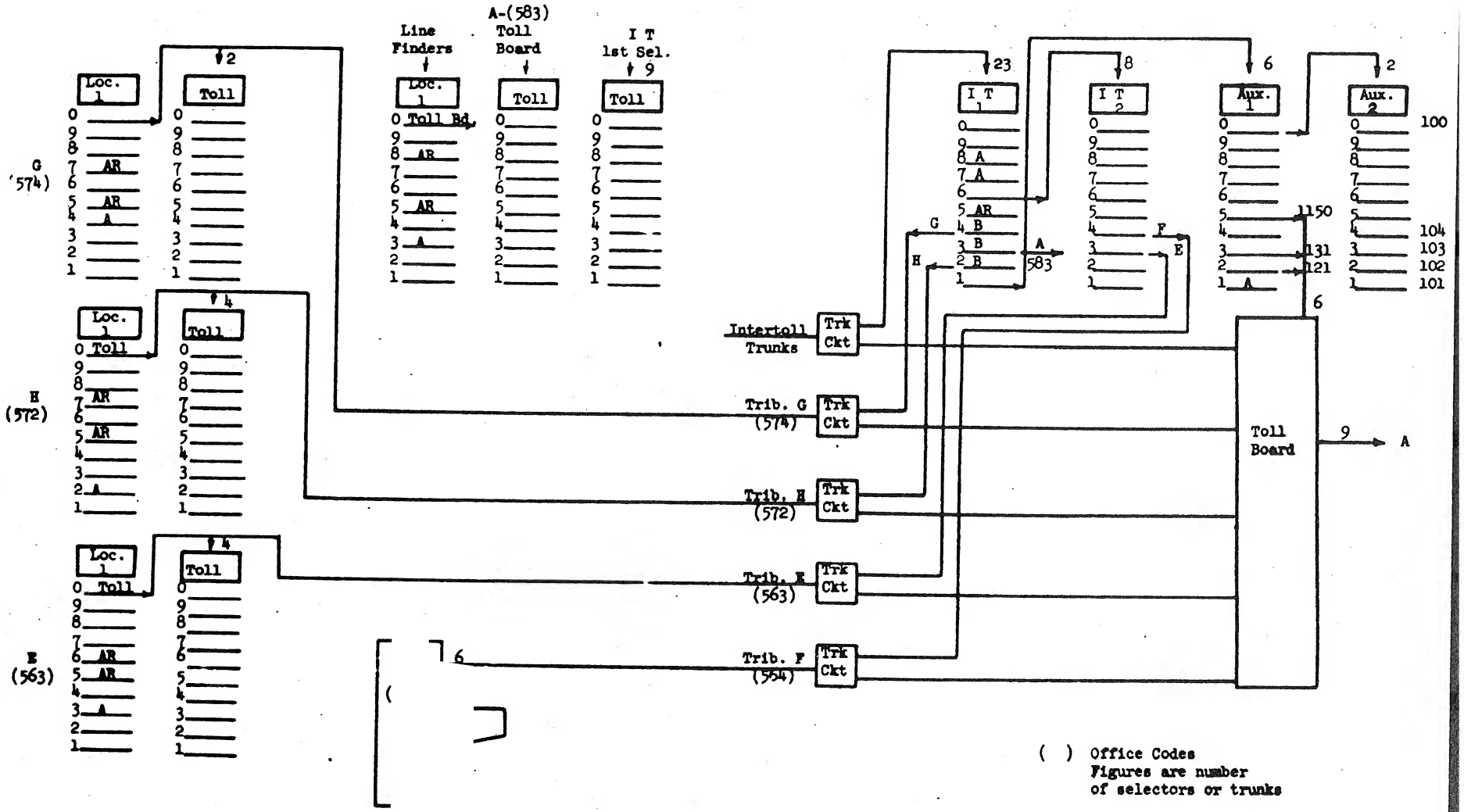
* Code Changed

○ Absorbed in Local Office

SCHEMATIC D

ALTERNATIVE SELECTOR ARRANGEMENTS - C, D

FIGURE 4



TOLL CENTER AREA - SWITCHING SCHEMATIC

FIGURE 5